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DAIRY WASTE TREATMENT BY AERATION

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INTRODUCTION

Dairy waste water is a nuisance in every dairy plant. Management must get rid of this waste water either directly or after its treatment. Direct disposal of waste water - its removal from the property without any treatment - is achieved most simply by means of a public sewer system. The use of sewers relieves management of any responsibility for operating a treatment system, but requires excellent housekeeping to keep the sewage service charge as low as possible. Direct disposal of waste water is also possible by sub-surface tile field, by spray irrigation, or by other applicable methods, but such disposal places on management some degree of responsibility for operating and maintaining the system. In spite of this, these systems are lower in cost and simpler to operate than a treatment plant.

Waste treatment is essential if waste-disposal facilities are not available. Treatment of any dairy waste water is technically feasible. It is generally more expensive than disposal and places a high degree of responsibility on management. The construction cost and the operating cost will vary with good housekeeping and water economy in the dairy.

Research on treatment of dairy waste has been underway at the Eastern Regional Research Laboratory since 1948 following the suggestion of the Subcommittee on Dairy Waste of the Dairy Industry Committee. Results have been published as phases of the study have been completed. These laboratory investigations were supplemented by a 3-year pilot-plant study at the Pennsylvania State University. Results, ideas, and concepts obtained in the laboratory have been verified in the pilot plant and adapted to industrial practice.

The object of this report is to present in a concise, simple and complete manner information on the treatment of dairy waste as derived from the above studies. For more specific detail, reference is made to the appended list of publications, which have been selected from a total of about 40 that have been published since this work was undertaken. It is anticipated that complete information on a 10,000-gallon pilot-plant study that was recently completed at the Pennsylvania State University will be available in a forthcoming University Engineering Bulletin.

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Every biological treatment system requires a definite minimum weight of oxygen which must be made available to the system. Whether this weight of oxygen is supplied by means of a trickling filter or by a pumped aeration system makes little difference. Unless the essential amount of 0.65 lb of oxygen for each pound of milk solids in the waste water is furnished, the system will become anaerobic with all of the obnoxious odors characteristic of such a decomposing mixture. In actual projects it may be necessary for the engineering design to supply somewhat more than this theoretical minimum amount due to the general configuration of treatment systems. The point is, however, that in the initial construction, this oxygen supply condition must be met either by a large capital investment, as in construction of trickling filters, or by a large electrical power charge as required in the activated sludge process.

In preparing the engineering estimate for the annual charge of waste treatment, the operations within the dairy play a most important part. Housekeeping is of great importance, and the continual cooperation of employees should be enlisted to reduce the milk-solids loss to a reasonable value. While it is possible for the sanitary engineer to design a waste-treatment plant which can treat large quantities of skim milk, whey, and discarded products, it is doubtful if management can justify the total daily operating cost of such a system. It is far more economical to segregate these concentrated materials and provide separate disposal by drying, feeding or other means.

The cost of the treatment plant is much less than that of conventional sewage design of municipal plants since unessential units are omitted and equipment is kept to a minimum. Further, operation may be completely automatic.

BASIC THEORY OF THE TREATMENT PROCESS

In the effective treatment of dairy waste water, chemical processes are not of sufficient merit to justify their cost and, for that reason, the biological processes are in greater favor. Fortunately, the biological process is based upon the fact that a mixed aerobic culture exists in the treatment system and utilizes the milk solids in the waste water as a food supply for its own growth and propagation. These purifying organisms are microscopic in size and are almost the same density as the waste water. Hence means must be provided for their retention and also for allowing the purified waste water to leave the waste-treatment system.

It is possible for the purifying culture of a treatment system either to exist on the surface of a coarse stone bed or to exist in suspension in the liquid. The trickling filter purification system has a very high initial cost and a low operating cost, whereas just the reverse is true for the liquid-suspension type (activated sludge); from a tax write-off standpoint, the latter may be more economical and attractive to management.

Obviously,any aeration system must not require a great deal of maintenance. Thus, if it were possible to dissolve enough oxygen by simply using an air pipe with many holes in it, such a unit would be preferable, in spite of its high power requirement, to a more efficient unit requiring frequent or almost continual maintenance attention.

In addition to the air supply furnishing the necessary oxygen, the air is also utilized to maintain complete suspension of the biological sludge culture. If the treatment process is not purifying the waste and is producing odors, then either the air supply must be increased until the process is aerobic, or the total weight of milk solids entering the treatment plant each day must be decreased by improved housekeeping.

After the minimum oxygen requirement of the milk waste and sludge culture has been satisfied, the use of excess air or oxygen will not accelerate the process since the rate of oxidation is a function of the liquid temperature.

PROCESS OPERATION

Fundamentally the process sequence of waste treatment involves only two units, the oxidation-purification tank and the sedimentation tank. In the case of a batch process, these two units may be combined, sedimentation occurring while the air supply is temporarily shut off.

The waste water should go directly to the oxidation tank without passing through any sedimentation chamber or surge tank in order to avoid putrefaction and its associated odors. After passing through a screening device, the waste should enter the oxidation tank in such a manner as to achieve the most complete intermixing. It is detained in this unit for 6 to 8 hours in order that the equilibrium concentration of activated sludge will not exceed 5,000 ppm. From this tank the waste can be discharged to the sedimentation tank, and from there to the outfall sewer. It is essential that the sludge in the sedimentation tank be returned continually to the oxidation tank in order to facilitate its own oxidation, or be removed from the system.

With the batch process, two hours sedimentation time will usually produce a satisfactory purification of the liquid contents by settling. Proper location and sizing of the outlet pipe will permit this color liquid to be decanted from the tank, after which the aeration must be resumed immediately in order to avoid odors and to oxidize the sludge cells.

The operation of a dairy waste-treatment system requires the same careful attention as the making of buttermilk or some similar process within the dairy. If its operation and maintenance are neglected and abused, then the process becomes out of balance and its degree of perfection is impaired. It is based upon fundamental biological laws of nature which no man or equipment can alter. However, by intelligent engineering and proper attitude of management, these fundamental laws of nature can be utilized to provide an efficient and relatively trouble-free means of dairy-waste treatment.

SELECTED LIST OF PUBLICATIONS

1. Hoover, S. R., and Porges, N. Treatment of Dairy Waste by Aeration. II Continuous Aeration Studies. Proc. 5th Industrial Waste Conference, Purdue University, 137-144 (1949).

2. Porges, N., and Hoover, S. R. Treatment of Dairy Waste by Aeration. I Methods of Study. Proc. 5th Industrial Waste Conference, Purdue University, 130-136 (1949).

3. Porges, N., Pepinsky, J. B., Hendler, N. C., and Hoover, S. R., Biochemical Oxidation of Dairy Wastes. I. Methods of Study. Sewage and Ind. Wastes, 22, 318-325 (1950).

4. Hoover, S. R., Jasewicz, L., Pepinsky, J. B., and Porges, N. Assimilation of Dairy Wastes by Activated Sludge. Sewage and Ind. Wastes, 23, 167-173 (1951).

5. Hoover, S. R., Pepinsky, J. B., Jasewicz, L., and Porges, N. Aeration as a Partial Treatment for Dairy Wastes. Proc. 6th Industrial Waste Conference, Purdue University, 313-319 (1951).

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7. Hoover, S. R., and Porges, N. Treatment of Dairy Waste by Aeration. U. S. Dept. Agr., Bur. Agr. and Ind. Chem. AIC 332; 7 pp. (March 1952).

8. Hoover, S. R., and Porges, N. Assimilation of Dairy Wastes by Activated Sludge. II. The Equation of Synthesis and Rate of Oxygen Utilization. Sewage and Ind. Wastes, 24, 306-312 (1952).

9. Porges, N., Jasewicz, L., and Hoover, S. R. Measurement of Carbon Dioxide Evolution from Aerated Sludge. Sewage and Ind. Wastes, 24, 1091-1097 (1952).

10. Jasewicz, L., Porges, N., and Hoover, S. R. Borax as a Preservative of Dairy Waste for the B. O. D. Test. Proc. 8th Industrial Waste Conference, Purdue University, 387-392 (1953).

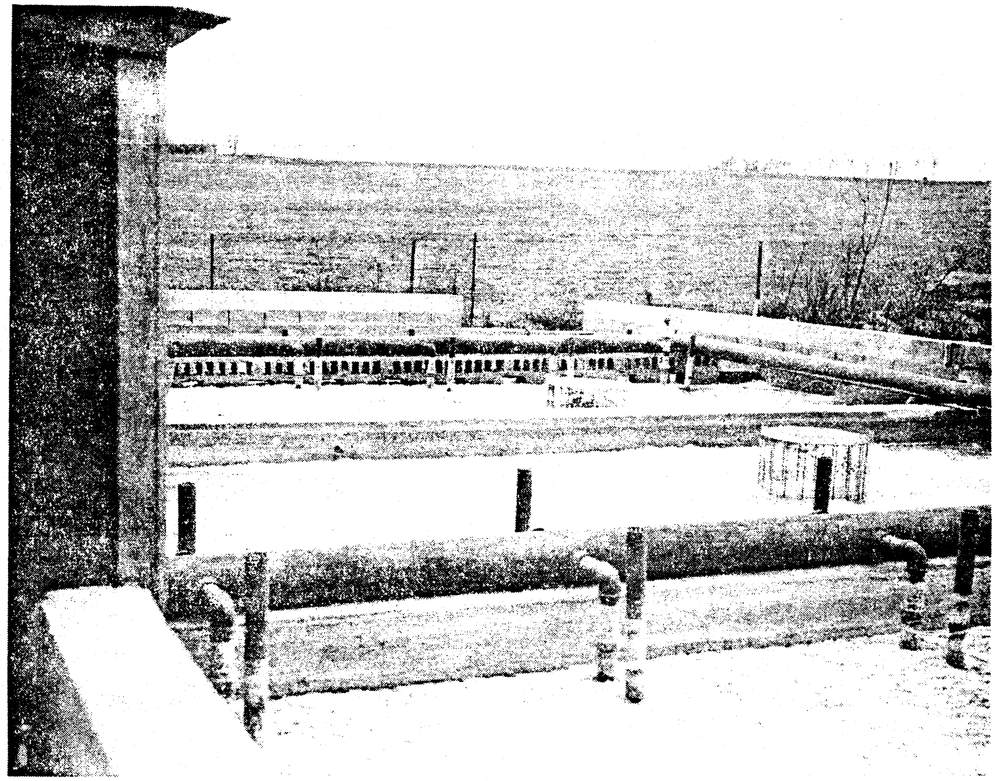

Figure I
Jet-aeration of 25,000 gallons of waste; fill-and-draw method.

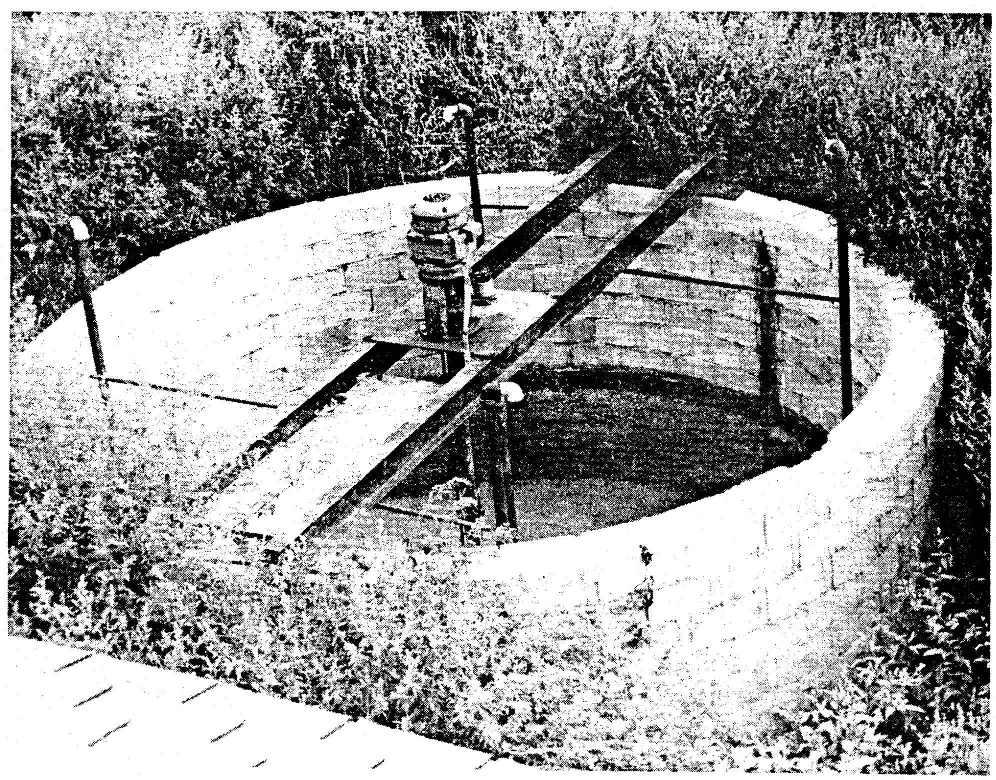

Figure 2
Four-jet aeration unit treating 6,000 gallons of waste; fill-and-draw method

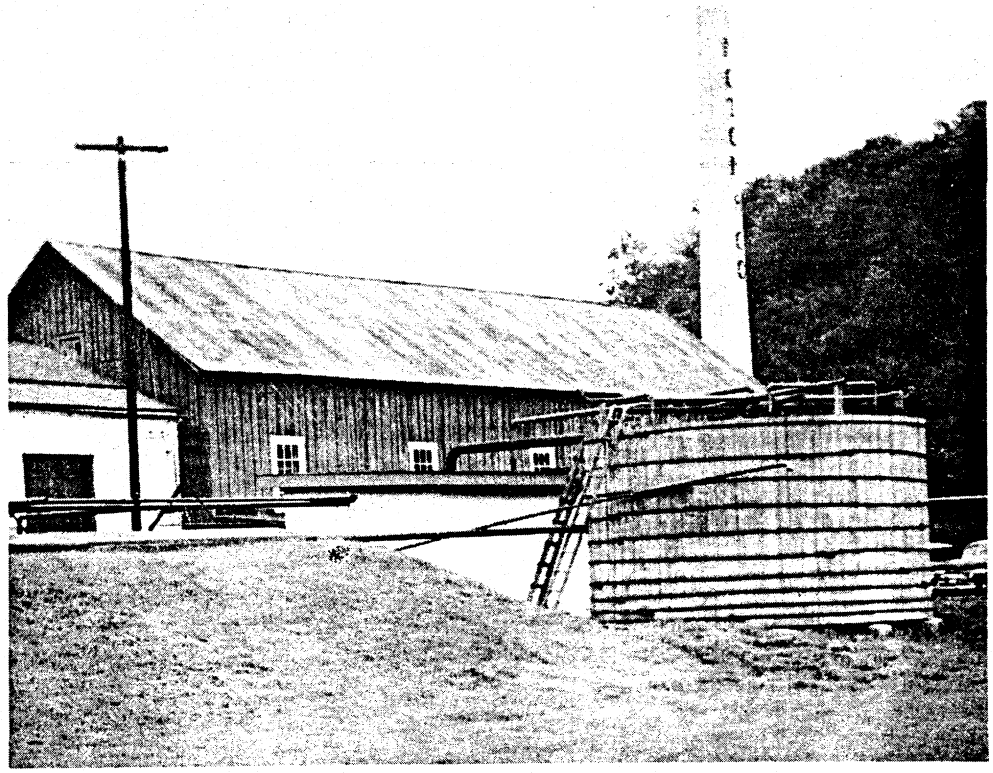

Figure 3
High-rate jet aeration under air pressure for continuous treatment of 22,000 gallons of waste.

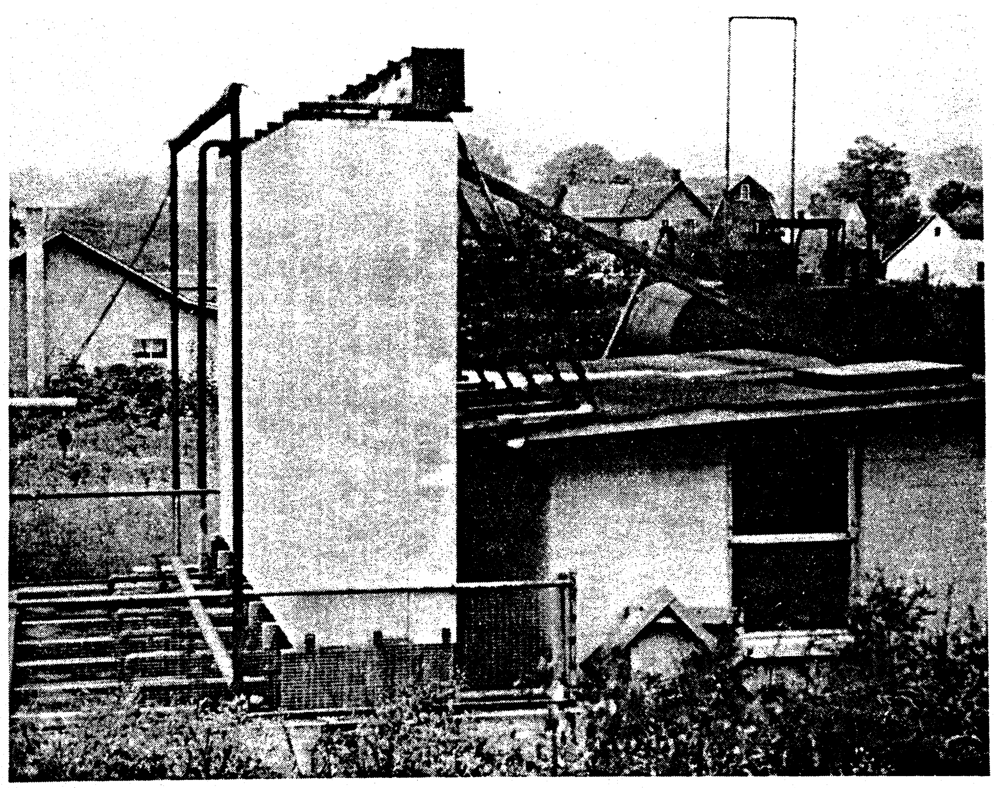

Figure 4
Combination jet and tower aeration for continuous treatment of 25,000 gallons of waste.